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NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
1002-30-4874	August 27, 1957	5448

FIRE ENDURANCE TESTS OF FOUR BULKHEAD ASSEMBLIES

by

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Fire Protection Section
Building Technology Division

for

U. S. Coast Guard

Authorization Nos. CGDB320-32-57
and CGDB306-12-56

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NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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ABSTRACT

Four bulkhead assemblies were subjected to standard fire tests to determine their suitability for approval by the U. S. Coast Guard for use on merchant vessels. The assemblies were tested in pairs. The specimens in each pair differed in the material making up the bulkhead panels; the pairs differed in the joint and mounting details. The unexposed surface temperatures of all four specimens remained within the specified limits for times between 16 and 25 minutes. The two specimens of the first pair were effective barriers to the passage of flame for less than 30 minutes; those of the second pair for the full 60 minute test period.

1. Introduction

At the request of the U. S. Coast Guard (letters of February 18, 1957 and July 31, 1957) two fire endurance tests were made in compliance with Subpart 164.008-3(b) of Specification for Bulkhead Panels for Merchant Vessels. Each fire test was made on two specimens of Marilite manufactured by the Asahi Asbestos Co., Ltd. of Tokyo, Japan.

2. Test Specimens

Within each pair of specimens, one was of Marilite P-1 in sheets about 7/8-in. thick, the other of Marilite PH using two thicknesses of about 3/8-in. each for a total of about 3/4-in. The first pair had the Marilite panels moderately well restrained. The steel joiner members were attached to the base supporting members and to a plate and angle across the top of each specimen. In the second pair

provisions had been made to allow the elements of the specimens to expand. The joiner members merely sat on the flanges of base channels and fit between ceiling trim elements. The base channel had stools welded to it intended to provide 3/4-in. clearance below the base. However, the stools collapsed under the weights of the specimens so the bases were blocked up. There was about 1-in. clearance between the furnace frame and the top of the marilite panels. The details of the various specimens are shown in figure 1.

3. Test Method

The two bulkheads of each pair were mounted in a single test frame that had been subdivided for bulkhead tests. Eight thermocouples were placed on the unexposed surface of each bulkhead. A felted asbestos pad 6- x 6- x 0.4 in. was placed to cover the junction and several inches of the wires of each thermocouple. The locations and distribution of these thermocouples are shown in figures 2 and 5. The furnace fires were controlled to produce temperatures as close as feasible to those defined by the standard time-temperature curve of ASTM E-119, which include 1000°F at 5 minutes, 1300°F at 10 minutes, 1550°F at 30 minutes and 1700°F at 1 hour. The furnace temperatures were indicated by thermocouples encased in porcelain insulators and iron pipes in the furnace chamber.

4. Results

The conditions of the two pairs of specimens immediately before test are shown in figures 2 and 5.

4.1 Test 390

The test of the first pair of specimens, in which the joiner members were secured, was conducted March 4, 1957. In addition to personnel of the NBS Fire Protection Section, the following were among those witnessing the test:

Wm. D. Ball, Jr., LCDR, USCG, Washington, D. C.
L. Coluccicllo, Lt., USCG, Washington, D. C.
R. H. Neisel, Johns-Manville Research, Manville, New Jersey
Burt Powers, Johns-Manville, Washington, D. C.

Several small bucklings developed in the exposed surface portions of both joiner members during the initial 3 minutes. The first crack in the unexposed surface of the P-1 (7/8 in.) specimen was observed at 10 1/2 minutes. A horizontal crack extended across the narrow section of the PH (3/4 in.) specimen at 17 minutes. The glow of the furnace fires was visible through a crack across the narrow section of the P-1 specimen at 21 minutes. The flicker of flames was visible through a similar crack in the PH specimen at 23 minutes. Both joiner members developed significant buckling and a piece of the 3/8 in. thick material was displaced from the exposed surface of the PH specimen at 27 1/2 minutes. The test was stopped at 29 minutes. The PH specimen had attained a maximum deflection of 2.3 in. at its center, and the P-1 specimen 2.0 in., as measured just before the end of the test.

The fire exposure severity was 94.2 percent. The times at which the limiting conditions were reached on the unexposed surfaces of the two specimens are given in the following table.

	P-1 (7/8 in.)		PH (3/4 in.)	
	Panel h:m	Joiner h:m	Panel h:m	Joiner h:m
250°F av rise	0:21.4	0:14.5	0:16.3	0:12.0
325°F max rise	0:23.9	0:11.0	0:19.1	0:11.5
Flame through	0:21		0:23	

The condition of the specimens after the tests are shown in figures 3 and 4.

4.2 Test 394

The test of the second pair of specimens, in which the joiner members were not attached to any other members and were able to expand without restraint, was conducted July 30, 1957. In addition to personnel of the NBS Fire Protection Section, the following were among those witnessing the test:

L. Coluccciello, Lt., USCG, Washington, D. C.
R. H. Heisel, Johns-Manville Research Center,
Manville, New Jersey
Burt Power, Johns-Manville, Washington, D. C.

Some smoke came from between the unexposed surface and the top trim of the F-1 specimen around 4 minutes. Minor local buckling of the exposed surface portions of the joiner members and base trim were observed at 13 minutes. Three areas of less than 1 ft^2 each on the exposed surface of the FM specimen showed flaking by 26 minutes. The unexposed surfaces of both specimens showed some localized browning along joiners or top trim by the same time. No cracks developed in the unexposed surface and only slight discoloration developed by the end of the test at 1 hour 2 minutes. The maximum observed deflections at the centers of the specimens were 0.7 in. for the FM specimen at 10 minutes and 0.6 in. for the F-1 specimen at 50 minutes and thereafter. The former was toward the fire, the latter away from it.

The fire exposure severity was 101.0 percent. The times at which the limiting conditions on the unexposed surfaces were reached are given in the following table.

	F-1 (7/8 in.)		FM (3/4 in.)	
	Panel h:m	Joiner h:m	Panel h:m	Joiner h:m
250°F av rise	0:21.0	0:07.4	0:20.2	0:08.1
325°F max rise	0:24.5	0:09.3	0:24.1	0:10.4
Flame through	None*	None*	None*	None*

*Slight local browning along joiner and top trim indicate passage of some hot gases, no flame observed.

The condition of the specimens after the test is shown in figures 6 and 7.

5. Discussion and Conclusions

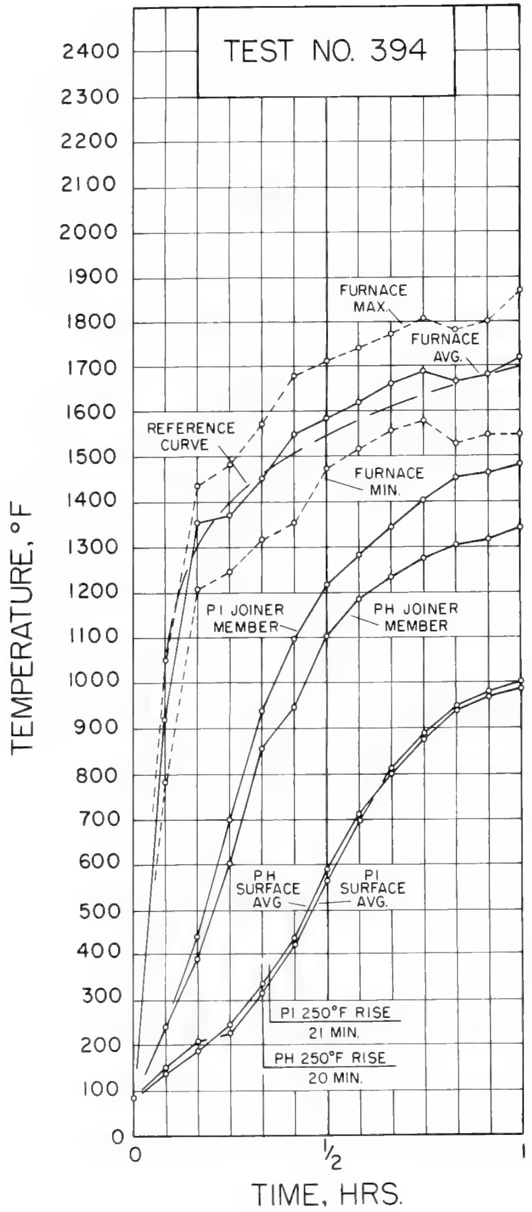
The results of test 390 showed that the panels were sufficiently resistant to heat transmission to hold the unexposed surface temperatures below the allowable limits for 16 to 24 minutes whereas the specification (USCG 164.008-3(b)) requires only 15 minutes. However, cracks developed which destroyed the flame barrier integrity of

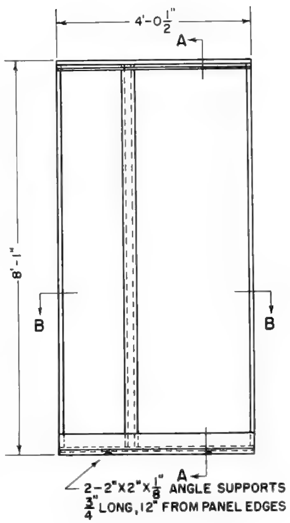
each specimen in 21 to 23 minutes. Therefore, neither specimen could qualify for any of the construction classes defined in the specification because at least 30 minutes integrity as a flame barrier is required.

The results of test 394 showed the importance of allowance for thermal expansion. The bulkhead panels and joiner members were identical to the corresponding specimen components of test 390, apparently. The significant differences between the two sets of test specimens were in the mounting systems which provided for thermal expansion in the latter test. As a result the two specimens remained effective barriers to the passage of flame for the full test duration of 1 hour, 2 minutes. The temperatures on the unexposed surfaces of the panels were within the specified limits for 20 to 24 minutes. Therefore, the particular specimens tested would both qualify for Class A-60 construction.

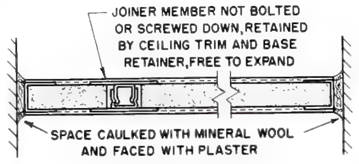
The use of an arrangement whereby the specimen may expand into a slot or groove is a good solution to the problem of thermal expansion. However, it can lead to weakness as a flame barrier. This weakness was avoided in the specimens tested by design and fabrication to provide good fit of the elements of closure around the expansion joint or area. Care during erection in the field, coupled with careful inspection, should be practiced to insure integrity as a flame barrier.

Fig. 1. Time temperature curves from test 394 and construction details

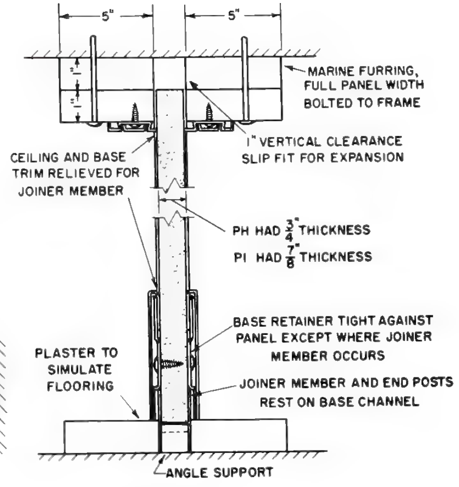




PANEL ELEVATION

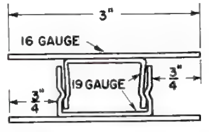

JOINER MEMBER NOT BOLTED OR SCREWED DOWN, RETAINED BY CEILING TRIM AND BASE RETAINER, FREE TO EXPAND
SPACE CAULKED WITH MINERAL WOOL AND FACED WITH PLASTER

SECTION B-B

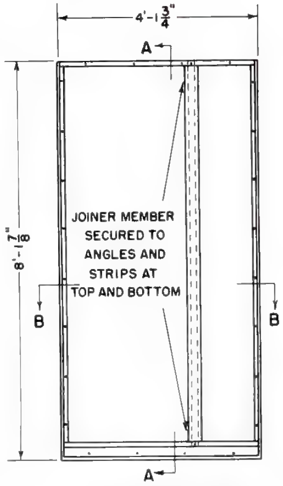

5"
5"
1"
1"
MARINE FURRING, FULL PANEL WIDTH BOLTED TO FRAME
1" VERTICAL CLEARANCE SLIP FIT FOR EXPANSION
CEILING AND BASE TRIM RELIEVED FOR JOINER MEMBER
PH HAD ¾" THICKNESS
PI HAD ⅞" THICKNESS
BASE RETAINER TIGHT AGAINST PANEL EXCEPT WHERE JOINER MEMBER OCCURS
PLASTER TO SIMULATE FLOORING
JOINER MEMBER AND END POSTS REST ON BASE CHANNEL
ANGLE SUPPORT

SECTION A-A

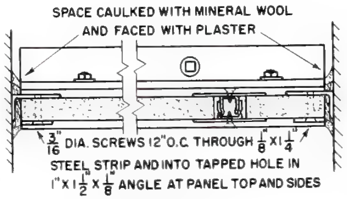
CONSTRUCTION DETAILS
TEST 394



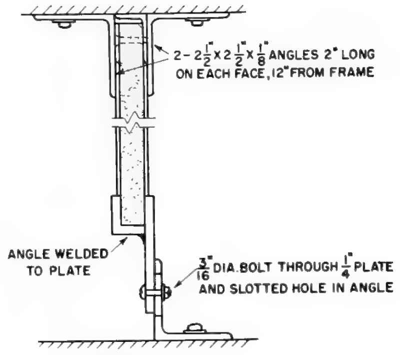
JOINER MEMBER
STANDARD FOR BOTH TESTS


4'-1¾"
A
8'-1⅞"
B
B
A
JOINER MEMBER SECURED TO ANGLES AND STRIPS AT TOP AND BOTTOM

PANEL ELEVATION


SPACE CAULKED WITH MINERAL WOOL AND FACED WITH PLASTER
$\frac{3}{16}$" DIA. SCREWS 12" O.C. THROUGH ⅛"x1¼" STEEL STRIP AND INTO TAPPED HOLE IN 1"x1½"x⅛" ANGLE AT PANEL TOP AND SIDES

SECTION B-B


2-2½"x2½"x⅛" ANGLES 2" LONG ON EACH FACE, 12" FROM FRAME
ANGLE WELDED TO PLATE
$\frac{3}{16}$" DIA. BOLT THROUGH ¼" PLATE AND SLOTTED HOLE IN ANGLE

SECTION A-A

CONSTRUCTION DETAILS
TEST 390

26735

Fig. 2. Specimens immediately before test 390.

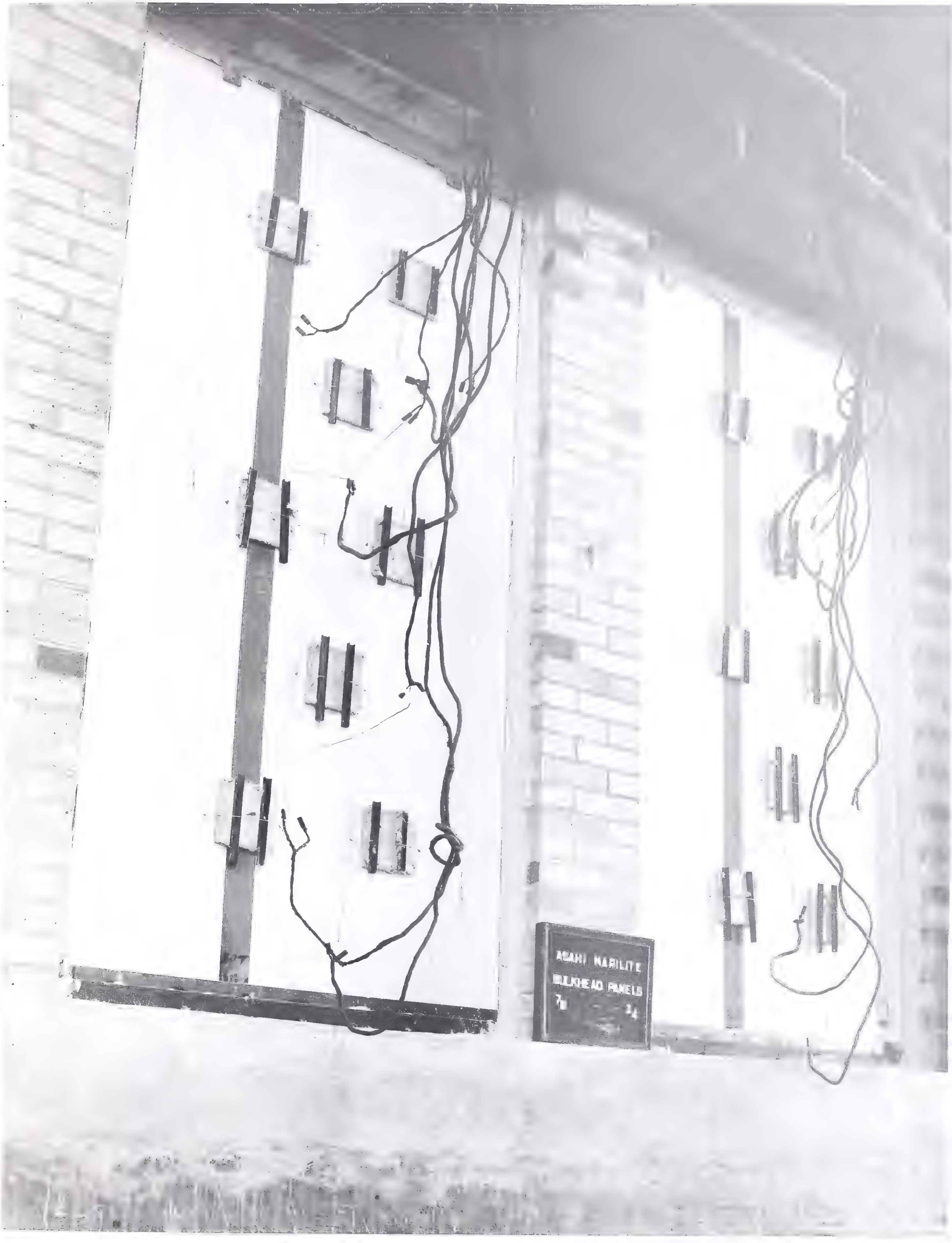

ASAHI MARILITE
BULKHEAD PANELS

Fig. 3. Unexposed surfaces of specimens at end of test 390

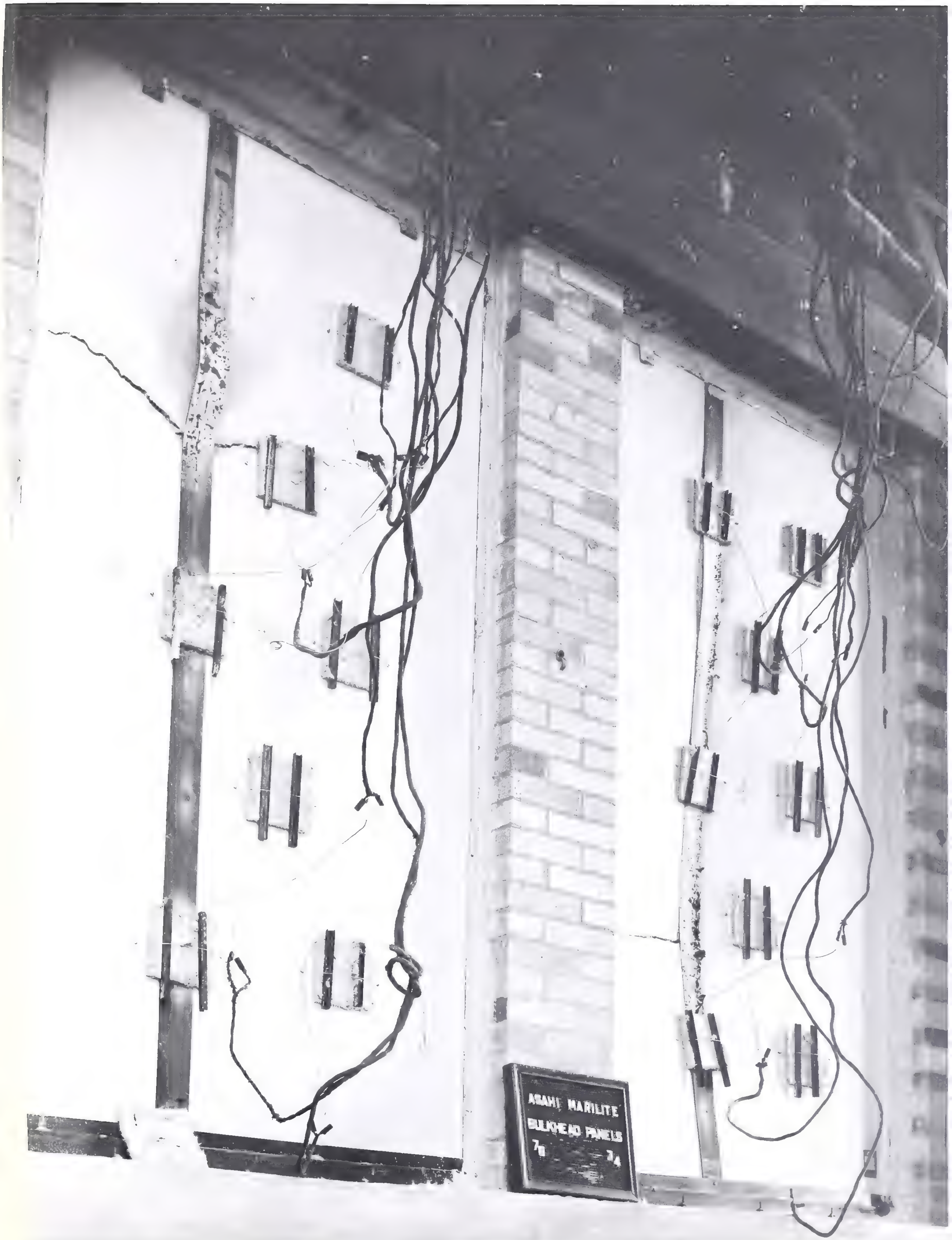

ASAHI MARILITE
BULKHEAD PANELS
7/8
3/4

Fig. 4. Exposed surfaces of specimens
after test 390

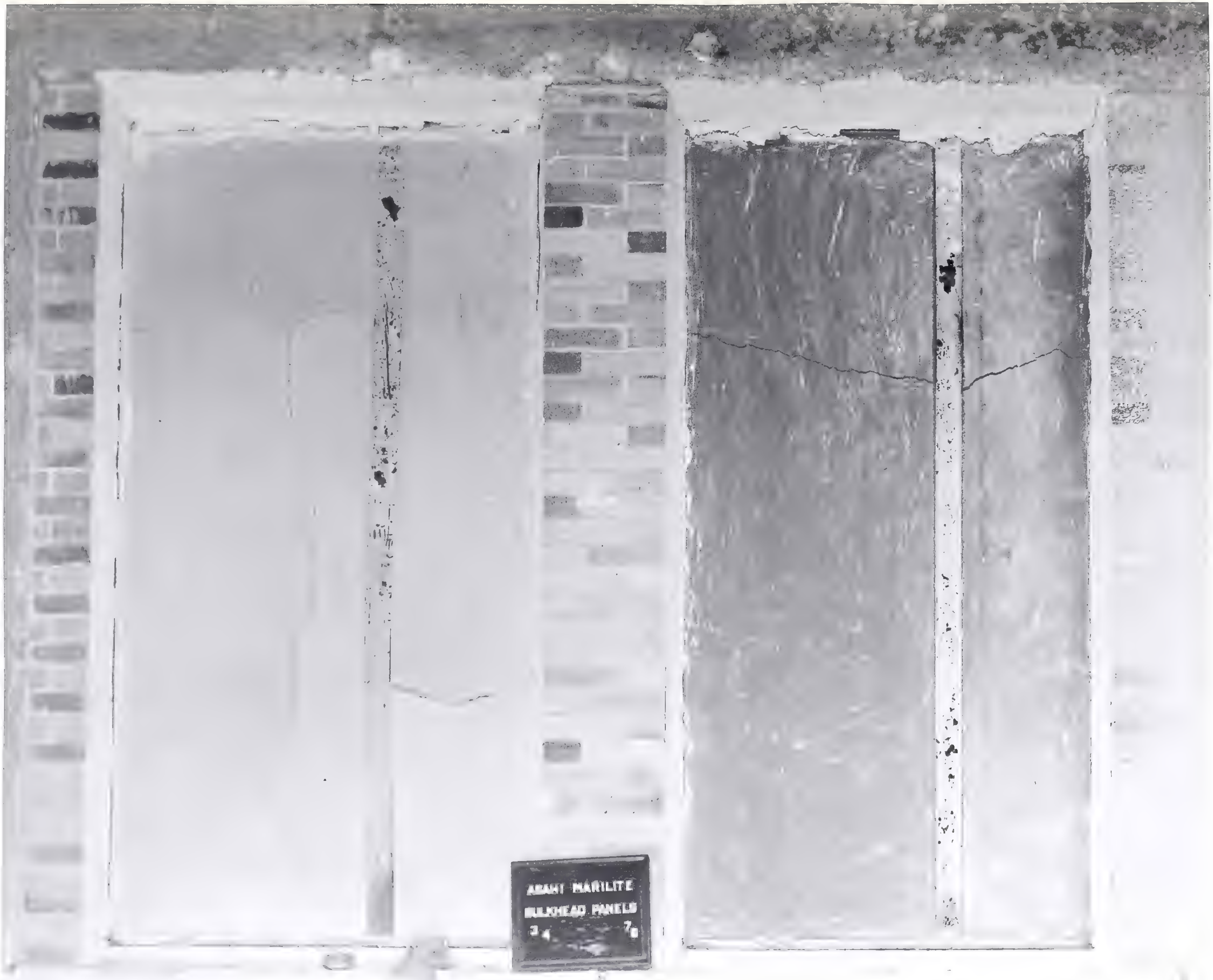

ASAHI MARILITE
BULKHEAD PANELS
3/4 7/8

Fig. 5. Specimens immediately before test 34.

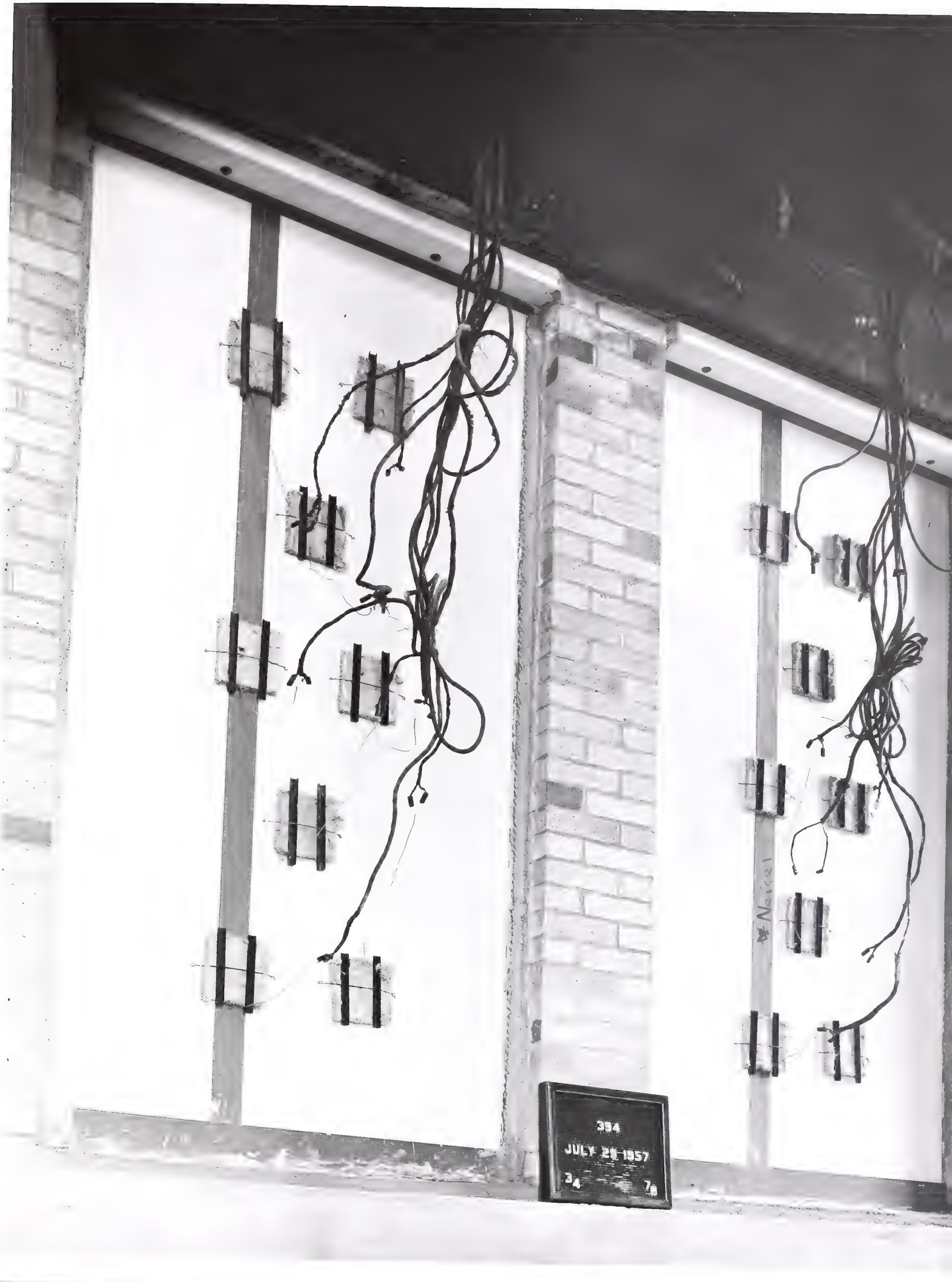
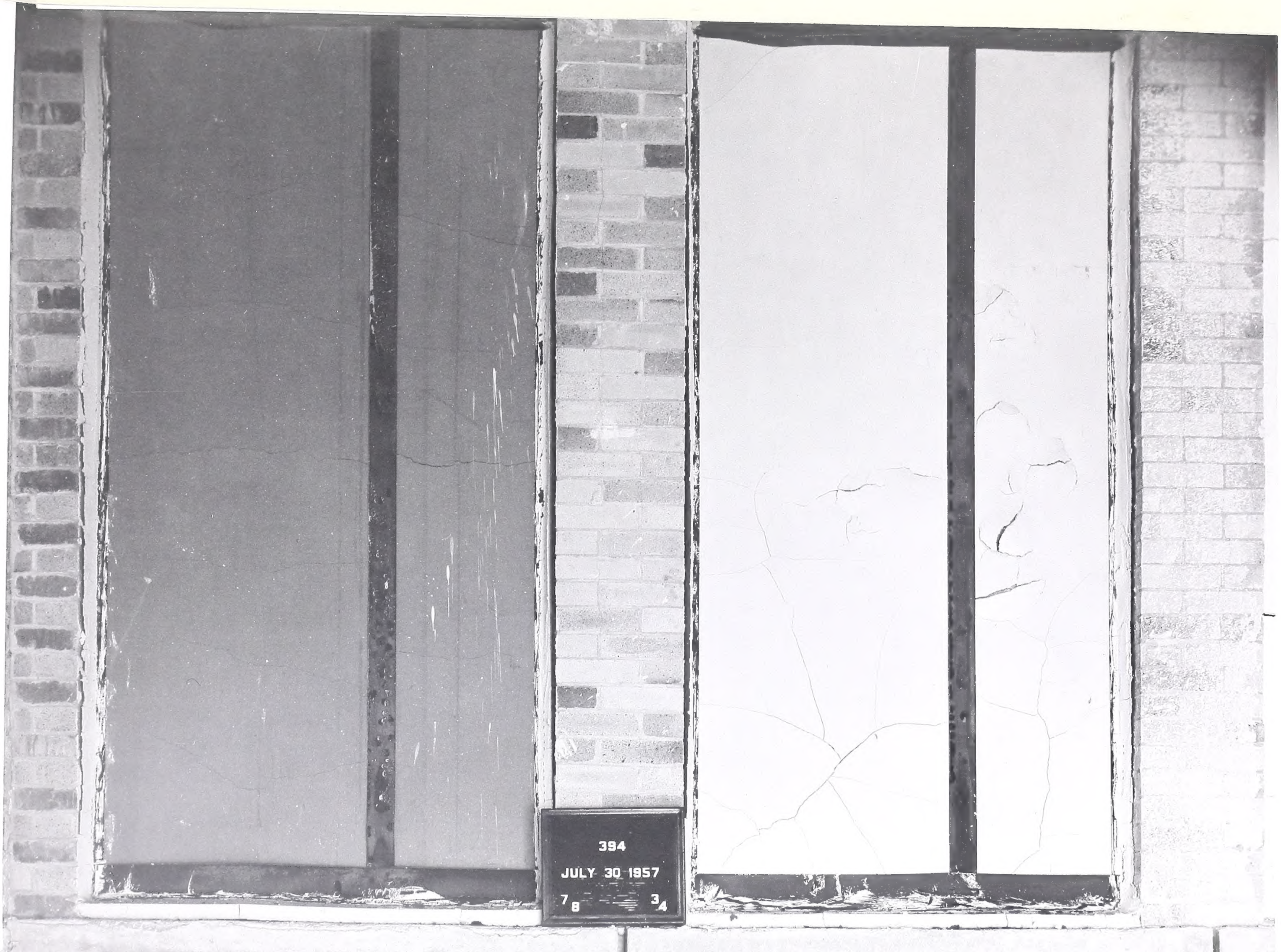

394
JULY 29 1957
34
7B
Neisel

Fig. 6. Unexposed surfaces of specimens
at end of test 34

Fig. 7. Exposed surfaces of specimens
after test 34


394
JULY 30 1957
7 8
3 4

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